The ecology of protozooplankton from natural aquatic habitats of Bundelkhand region

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(Date of Receipt : 02-01-2013; Date of Acceptance for Publication : xx-xx-xxxx)

Abstract

Protozoa represent one of the main components of zooplanktons and play a significant role in fresh water ecosystems. Among these, ciliates and flagellates are the most striking members and have long been of ecological interest. The seasonal changes of the abundance and biomass of protozooplankton were investigated by a live-counting technique in the eutrophic aquatic bodies of Bundelkhand region. During the investigation, the percentage contribution of the different protozoan groups changed sigficantly. In the present study we observed 44 protozoan species from different aquatic bodies of Bundelkhand region. Nineteen species were regarded as ciliates (*Paramecium caudatum, P. aurelia, P. burseria,Vorticella, Euplotes, Spirostomum, Coleps, Stentor, Epistylis, Loxodes, Didinium, Dileptus, Urocentrum, Cyclidium, Stylonchia, Colpoda, Tetrahymena, Amphileptus, Chilodonella.* 9 different species of flagellates *Phacus, Euglena viridis, E. acus, E. spirogyra, E. oxyuris, E. gracilis, Volvox, Chlamydomonas*),10 different species of Amoebae (*N. fowleri, N. gruberi, Amoeba proteus, Schizopyrenus jugosa, Hartmannella vermiformis, Acanthamoeba culbertsoni, Acanthamoeba rhysodes, Acanthamoeba castellanii, Acanthamoebae palestenensis, Echinamoeba exudans),* 4 testaceans *(Arcella vulgaris, Centropyxis, Nebella, Difflugia*) and 2 heliozoans (*Actinophrys and Actinosphaerium* are isolated and examined. Ciliates and Flagellates dominated in late spring, summer and autumn. Out of the observed Protozoans prevalence rate of ciliates and flagellates was grater than other fresh water protozoan and formed 70% of protozoan biomass on annual average.

Keywords : Protozooplankton, Biomass, Bundelkhand, Ciliates, Flagellates, Heliozoans, Amoebida.

Pages: 9 References: 40

INTRODUCTION

Protozoans are eukaryotic organisms, which exhibit considerable morphological and physiological diversity (Shukla and Sharma, 2010). The protozoa are considered to be a subkingdom of the kingdom protista, although in the classical system they are placed in the kingdom Animalia. More than 64,000 species have been described, most of which are free living organism. Protozoa are found in almost every possible habitat (Shaikh *et. al.*, 2012). They are ubiquitously distributed in different habitats and ecologi-

cally very important. They are not only an important component of food chain in water, but also attribute to the structure and function of ecosystem (Xu and Wood, 1999 and Patterson, 2007). Protozoan diseases range from very mild to life-threatening. Individuals whose defenses are able to control but not eliminate a parasitic infection become carriers and constitute a source of infection for others. The organelles of protozoa have functions similar to the organs of higher animals. The plasma membrane enclosing the cytoplasm also covers the projecting locomotory structures such as pseudopodia, cilia and flagella. The ciliates are group of protozoans characterized by the presence of hair like organelles called cilia, which are identical in structure to flagella but typically shorter and present in much larger numbers with a different undulating pattern than flagella. Cilia & compound ciliary organelles occur in all members of the group and variously used in swimming, crawling, attachment, feeding and sensation (Finlay, 1988). Most of the protozoa feed on bacteria while some are capable of photosynthesis and other can absorb dissolved organic substances caused by bacterial decomposition. Aside from food, almost all protozoa need oxygen for their living. Hence, dissolved oxygen is an important factor for the growth of protozoa. The abundant areas for the survival and growth of protozoa are fresh water resources available with moderate amount of bacteria and dissolved organic substances as well as proper oxygen (Charubhun and Charubhun, 2000). They are also mediator for recycling nutrient essential for microbial growth and also for micro-ecosystem (Pratt and Cairns, 1985 and Baldock, 1986).

Protozoa are cosmopolitan and tolerate a wide range of physico-chemical factors like temperature, pH, dissolved oxygen, hardness and salinity. They are not randomly distributed, but live in microhabitats, small regions that may be as tiny as a few cubic centimeters, within a body of water or a moist environment such as soil, vegetation, or the bodies of plants and animals (Bamforth, 1985). They occupy many different biotopes as well as eutrophic and oligotrophic aquatic bodies (Olenin and Ducrotoy, 2006). Therefore, some species of protozoa are used as preliminary indicators identifying the characteristics and quality of water body. Therefore we have decided to undertake the study of ecology of protozoolpankton with reference to water quality in the region of Bundelkhand. Since protozoa are generally observed microorganism, the investigation of fresh water protozoa in Bundelkhand region would provide biological database on protozoolpankton diversity and ecology.

MATERIALS AND METHODS

Most fresh water protozoa are phagotrophic and eat bacteria, algae and small biomass of other organic particles. They tend to be abundant in habitats where productivity is high, soft sediments supporting particularly high numbers. In the present study the water samples were collected from different provinces representing five regions of Bundelkhand named Orcha (Station 1), Jhansi(Station2), Pariksha (Station3), Moth (Station4) and Chirgaon (Station5). Water samples were collected from ponds, ditches, canals and reservoirs in Bundelkhand region of U.P., during the month of summer, monsoon and winter (2010-2011). Some physico-chemical parameters such as Temperature, pH, Dissolved Oxygen (DO), Total Alkalinity and Total Hardness were measured as per standard methods for the examination of water samples (APHA *et. al.*,2002) and observation of fresh water protozoa were examined under microscope. Living specimens of fresh water protozoans were identified and photographed in the laboratory at the Department of Zoology, Faculty of Science, University of Lucknow, using techniques described by Brusca and Brusca (1990), Kudo (1966), Patterson and Hedley (1992), K.G.Grell (1973) and Ruppetry et al (2004). The classification of main groups of protozoa was based on their structural features, feeding, movement and reproduction. Group identification of protozoa was considered, though there would be some differences in one or more biological features, for instance, some flagellates were heterotrophy consuming organic substances while some had chloroplast for photosystesis.Protozoa classification following Lee *et. al.*, (1985), Levine *et. al.*,(1980) and Corliss (1998)'s using standard protozoological keys.

RESULTS AND DISCUSSION

The findings of various physico-chemical parameters studied were shown in Table 1 to 5. For all determination of parameters standard methods were used (APHA *et. al.*, 2002). The distribution and abundance of fresh water protozoan of aquatic communities is governed by a variety of ecological factors. The physico-chemical parameters vary from place to place and interact with each other. Therefore, it is difficult

to draw specific conclusions concentrating upon the specific effect of any single factor on the population density. However some generalized interrelationship among the physico-chemical parameters and the population can be established. In the present study we observed 44 protozoans from different ponds of five regions of Bundelkhand locality. 19 species of them were a ciliates (*Paramecium caudatum, P. Aurelia, P.burseria, Vorticella, Euplotes ,Spirostomum, Coleps, Stentor, Epistyles, Loxodes, Didinum, Dileptus, Urocentrum, Cyclidium, Stylonchia, Colpoda, Tetrahymena, Amphileptus, Chlodonella*) nine different species of flagellates, (*Phacus, Euglena viridis E.acus, E. spirogyra, E. oxyris, E. gracilis, Volvox, Chlamydomonas*). Ten species of Amoebae, (*N.fowleri, N.gruberi, Amoeba proteus, Schizopyrenus jugosa, Hartmannella vermiformis, Acanthamoeba culbertsoni, Acanthamoeba rhysodes, Acanthamoeba castellanii, Acanthamoebae palestensis, Echinamoeba exudans*), four testaceans (*Arcella vulgaris, Centropyxis, Nebella,. Difflugia*) and two Heliozoans,(*Actinophrys, Actinosphaerium*) are isolated and examined (Table-6 & Fig-1). Out of the observed protozoans prevalence rate of ciliates and flagellates was greater than other fresh water protozoan. The prevalence rate of Ciliates was 43.18%, Flagellates show 20.45%, Amoebida has 22.73%, Testaceans show 9.09% and Heliozoans show 4.55 %.(Fig: 2)

During the present study temperature recorded were normal during different seasons ranging between 30.0 -32.1, 28.9-30.5 and 19.4 -21.70C in summer, monsoon and winter seasons respectively (Table-1). The pH values of water were found to vary from7.28-7.98, 7.53-8.40 and 6.38-8.33 in summer, monsoon and winter seasons respectively. The pH showed an alkaline range throughout, rarely it was acidic (Table-2). This is due to enhanced photosynthetic activity during summer season and dilution of industrial and sewage effluents (Khanna and Bhutiani, 2003). Dissolved Oxygen ranged from 7.1-9.7 mg/L,8.3-9.5 mg/L and 9.0-11.3mg/L in summer, monsoon and winter seasons respectively (Table-3). DO was more in winter and less in summer. Lower DO might be due to the fact that respiratory demand of the algal blooms exceeded the photosynthetic activity (Murugesan et al, 2007).Total Hardness ranged between 310-398 mg/L, 214-264 mg/L and 205-314mg/L in summer, monsoon and winter respectively(Table-4). The hardness was more in summer, moderate in winter and less in monsoon. This may be because as the summer season proceeded, water volume shrink and nutrient concentration increases(Pandey and Verma,2004).The Total alkalinity of water samples ranged between 163-209 mg/L, 224-350mg/L and 127-189mg/L respectively in summer, monsoon and winter season(Table-5).Alkalinity was maximum in monsoon and minimum in winter. Protozoa, representing the main component of zooplankton, play significant roles in fresh water ecosystems (Fenchel, 1987). Among these organisms ciliates are the most striking members and have long been of ecological interest. Several investigations have been made on the quantitative importance of ciliates (Laybourn-Parry et al, 1990 a, b; Arndt *et. al.*, 1993; Schonberger, 1994 and Pradhan and Shaikh, 2011).The relative densities of ciliates deferred during all the seasons. In general the population density was more in winter less in monsoon and least in summer. In present study the atmospheric and water temperature showed identical fluctuation. The hydrogen ion concentration is also consistently higher and this may be one of the contributing factors. Whereas in summer high temperature and low percentage of oxidizable organic matter have been noted and this might have affected the protozoan density. The ciliate densities during monsoon are consistently lower than that of winter but more in summer. The patterns of fluctuations are directly associated to temperature, Dissolved oxygen, oxidizable organic matter and hardness of water. Shaikh et al (2012) reported 10 species of fresh water protozoan from water bodies of Salim Ali Lake, Aurangabad and according to him the distribution and population of protozoa influenced with water temperature, light, pH, acidity, food availability and degree of adaptability of individual protozoa to various environmental changes. The distribution and abundance of fresh water protozoa is guided similarly to other microbial communities by a variety of ecological factors. Some of the factors exhibit great variability from place to place and time to time. The environmental conditions, in which protozoan can live and multiply, there is always an optimum range for each group. Charubhun and Charubhun (2000) reported 259 species of fresh water protozoan from different provinces of Thailand. According to him, the survival and growth of protozoa are fresh water resources available with moderate amount of bacteria and dissolved organic substances as well as proper oxygen content in aquatic ecosystem. The higher abundance and biomass values were mainly attributed to the

abundant algae life and may significantly increase the availability of protozoan food resources (Sorokin & Pavelijeva, 1972).Prevalence percentage of Heliozoans were scarce in winter season and reaching the summer peak, and then decreased again to the lowest winter season.Testaceans biomass were highest in summer and minor in late winter season because temperature of water body favors its establishment in several habitats(Sigala-Regalado et al,2011).

Cyst production by protozoa is a natural part of the life-cycle, but often is a response to unfavorable environmental factors, such as desiccation, temperature, or starvation, and is triggered in response to these conditions. Cyst formation has been documented in the species of genera, *Colpoda, Actinophrys, Paramecium, species of Naegleria, Acanthamoeba, Hartmennella and Amoeba proteus* (Hausmann and Hulsmann, 1996), which were found at aquatic bodies of Bundelkhand region and this capability facilitates the presence of these species in different seasons inside the water body. The dynamics of protozoan community may well be explained by changes in the impact of bottom-up and top-down effects. Protozoan hervivory probably had an important impact on phytoplankton mortality during the early summer season. The majority of sarcodines apart from the heliozoans are usually associated with surfaces, and especially sediments. The amoebae and testaceans have also been reported from lake (Finlay and Esteban, 1998).In similar type of study from Northern Ireland, 108 protozoan taxa were observed from a fresh water lake (Xu and Wood,1999) comprising 18 flagellates, 71 ciliates and 19 sarcodines.Page and Siemensma(1991) reported 109 species of heliozoans from fresh water body along with characteristic of water quality. Foissner(1992) recorded a list of 282 species of heterotrophic flagellates isolated from various fresh water sources. Wilkinson and Smith (2006) described 52 taxa of terrestrial protozoa in which 11 flagellates,8 gymnamoebae,1heliozoan,11 ciliates and 21 testate amoebae were reported. Ahmad and Sharma (2009) reported 47 protozoan taxa comprising 10 flagellates, 17 ciliates,20sarcodines among which 2 testaceans and 2 heliozoans from different ponds of Lucknow locality. These findings are in conformity with our results also. Hawthorn and Ellis-Evans (1984) reported 82 species of benthic protozoa comprising 33 flagellates, 15 rhizopods, 4 heliozoans and 30 ciliates from a variety of Maritime Antarctic fresh water lakes and pools. According to them flagellates and ciliates showed the greatest species diversity but flagellates and amoebae were dominant numerically with support of ecological parameters of water body. Seasonal fluctuations, both in major groups (Flagellates and Rhizopods amoebae) and individual species were linked with fluctuations in number, physico-chemical characteristic of water and also the activity of algae and bacteria.

The tiny creatures is not only an protozoan, the tiny plays indicator of pollution but plays an important role in breaking down the organic pollutants and thus is highly useful in reducing the damage due to pollution. The different species of fresh water protozoa (Ciliates, Flagellates, Amoebida, Heliozoans and Testaceans) were recorded they were active participant within phytoplankton food webs.Therefore,ignorance of Protozoans in most routine zooplankton investigations will surely result in severe underestimation of the role of Protozoans in plankton food webs, and Protozoans should be paid more attention to in the future zooplankton investigations in relation to the physico-chemical parameters of water bodies.

ACKNOWLEDGEMENT

Authors are thankful to the Head, Department of Zoology, University of Lucknow, Lucknow for providing necessary facilities and encouragement.

Table-1
Seasonal Variation in Phyisco-Chemical Characteristics (Temperature) of Water Samples Collected from Bundelkhand Region

Station No	Summer	Monsoon	Winter
1	35.5	30.5	20.4
2	30.2	29.3	19.8
3	31.1	28.9	19.6
4	32.1	29.6	21.7
5	30.0	29.1	19.4

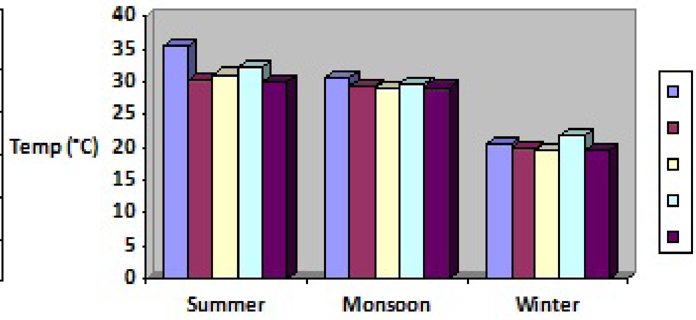


Table-2
Seasonal Variation in Phyisco-Chemical Characteristics (pH) of Water Samples Collected from Bundelkhand Region

Station No	Summer	Monsoon	Winter
1	7.84	8.10	8.33
2	7.98	8.40	8.07
3	7.51	7.63	6.62
4	7.86	7.77	6.52
5	7.28	7.53	6.38

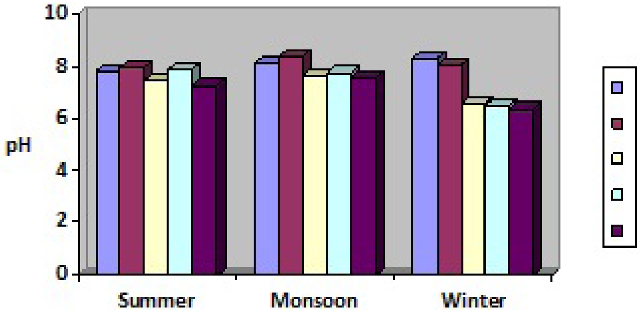


Table-3
Seasonal Variation in Phyisco-Chemical Characteristics (Dissolved Oxygen) of Water Samples Collected from Bundelkhand Region

Station No	Summer	Monsoon	Winter
1	7.5	9.2	10.9
2	7.1	8.3	11.3
3	8.8	8.5	9.0
4	9.7	8.7	10.9
5	9.4	9.5	10.4

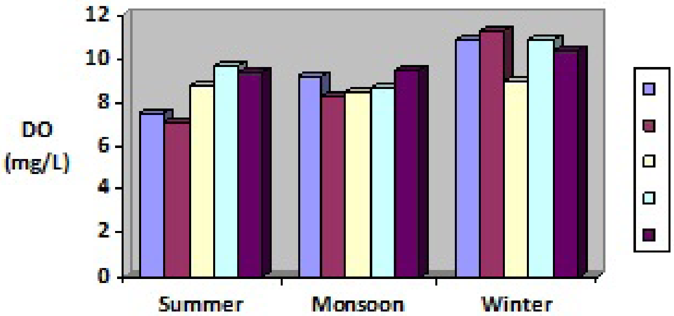


Table-4
Seasonal Variation in Phyisco-Chemical Characteristics (Total Hardness) of Water Samples Collected from Bundelkhand Region

Station No	Summer	Monsoon	Winter
1	398	214	257
2	329	256	205
3	310	225	314
4	327	264	206
5	390	227	283

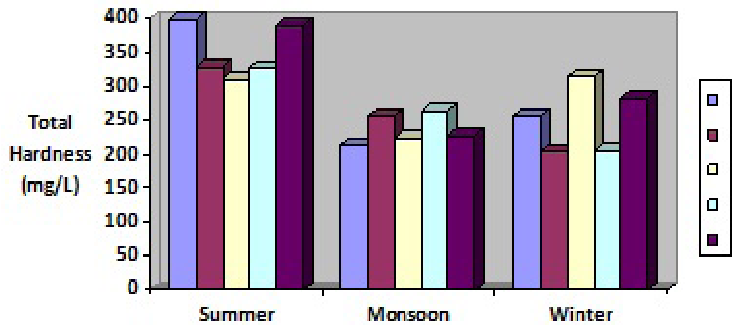
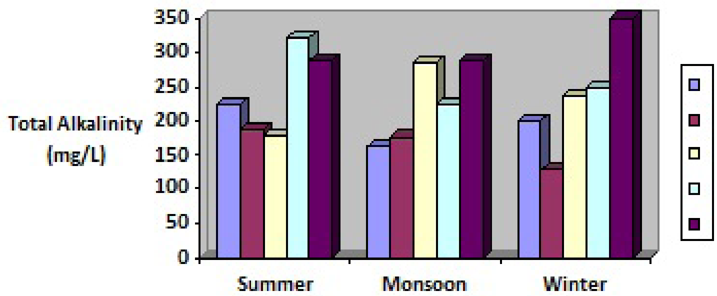


Table-5
Seasonal Variation in Phyisco-Chemical Characteristics (Total Alakilinity) of Water Samples Collected from Bundelkhand Region

Station No	Summer	Monsoon	Winter
1	201	321	189
2	178	224	127
3	238	350	180
4	163	252	163
5	209	289	180



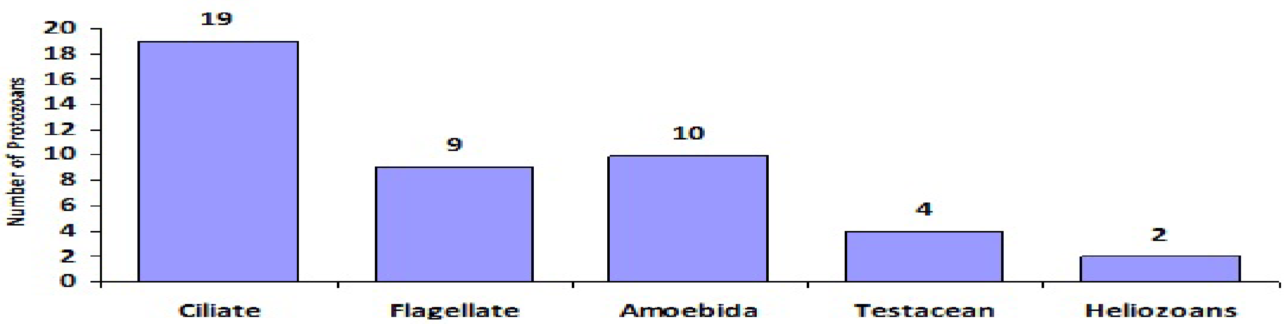


Fig-1 Showing number of fresh water protozoans from water samples.

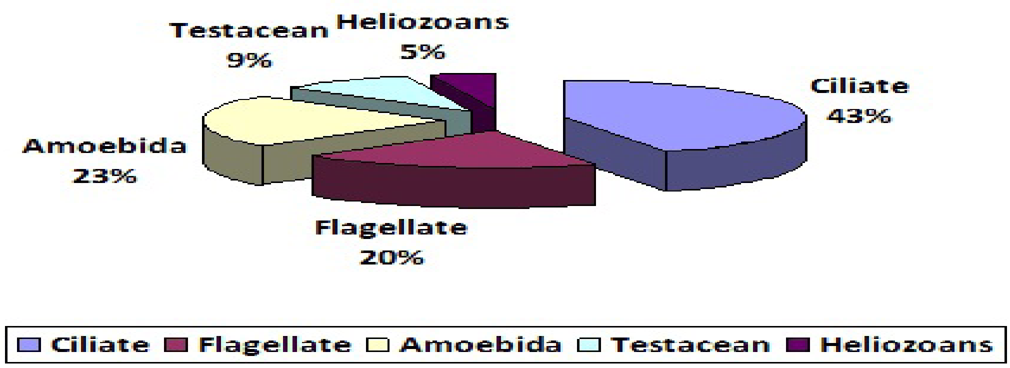


Fig 2 - Showing percentage of fresh water Protozoans from water samples.

Table-6

Protozoan taxa Collected from Bundelkhand Region

Flagellates	**Ciliates**	**Amoebida**
Phacus sp.	*Paramecium caudatum.*	*Naegleria .fowleri.*
Euglena viridis.	*P. Aurelia.*	*N.gruberi.*
E.acus.	*P.burseria.*	*Amoeba proteus*
E.spirogyra.	*Vorticella sp.*	*Schizopyrenus. jugosa*
E.oxyris.	*Euplotes sp.*	*Hartmanella vermiformis.*
E.gracilis	*Spirostomum sp.*	*Acanthamoeba culbertsoni.*
Volvox sp.	*Coleps sp.*	*Acanthamoeba rhysodes.*
Chlamydomonas sp.	*Stentor sp.*	*Acanthamoeba castallenii.*
	Epistylis sp.	*Acanthamoebae palestenensis.*
	Loxodes sp.	*Echinamoeba exudans.*
	Didinium sp.	
	Dileptus sp.	
	Urocentrum sp.	
	Cyclidium sp.	
	Stylonchia sp.	
	Colpoda, sp.	
	Tetrahymena, sp.	
	Amphileptus sp.	
	Chilodonella, sp.	
Testaceans	**Heliozoans**	
Arcella vulgaris.	*Actinophrys sp.*	
Centropyxis sp.	*Actinosphaerium sp.*	
Nebella sp.		
Defflugia sp.		

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